Section 919. PERMANENT TRAFFIC SIGN AND SUPPORT MATERIALS

919.01 General Requirements. Permanent traffic signs and sign support materials must conform to the MDOT sign support typical plans and this section. Cantilever, truss, breakaway column, and aluminum structure inspection shall be according to section 707 and this section.

919.02 Traffic Signs. Signs are classified by type of sign panel material and type of sign face, as follows:

Sign Panel:

Type	Material
I	Aluminum Extruded Sections
II	Plywood
III	Aluminum Sheet
IV	Aluminum Sheet Overlay

Sign Face:

Type	Background	Legend
A	Reflectorized	Reflectorized
B	Reflectorized	Non-reflectorized
C	Non-reflectorized	Reflectorized

A. **Sign Panel Material.**

1. **Aluminum Extruded Sections.** The sections shall be supplied in various widths and shall have a plain butt-type edge for connecting to adjoining horizontal sections. The sections shall be one-piece with no vertical splices and shall have a cross-sectional shape meeting the minimum requirements specified in Table 919-1. The section shall have a minimum nominal thickness of 0.125 inch. Exterior corners shall have a minimum radius of 0.040 inch.

   The sign panel sections shall be extruded aluminum alloy 6063-T6 conforming to ASTM B 221. The panel sections, after fabrication, shall have a flatness equal to or less than 0.031 inch per foot of length and 0.004 inch per inch of width.

   Aluminum extruded sections for sign panels shall be thoroughly degreased according to the sheeting manufacturer's recommendations. After degreasing, surface treating, and proper rinsing, all sign panels shall be kept free of grease, oil, or other contaminants.

   The sections shall be connected horizontally with ⅜-inch diameter stainless steel bolts. The bolts shall be spaced as shown on the sign support typical plans. Section connections or sign to post connections shall have no fasteners which project through the face of the sign panel.

Table 919-1 Cross-Sectional Requirements for Extruded Aluminum Sign Sections for Type I Sign Panels*

Length of Sign Type of Support	Moment of Inertia, Minimum	Section Modulus Minimum	Elements of Cross Section			
			No Free Ends		One Free End	
			b/t	Min. I/y	b/t	Min. I/y
Up to 30 feet on Columns Up to 20 feet on Cantilevers Up to 30 feet on Trusses	0.94 W	0.55 W	8-50	56.0 C	5-28	32.0 A
			Over 50	3.4 D	Over 28	11.6 B

b = the compression width of any stiffener element in inches.
t = the thickness of the stiffener element in inches.
I = moment of inertia of the sign section in inches^4.
y = the distance from the neutral axis to the centroid of the compression width of the element.
W =the width of the sign section in feet.
A = W/(63-b/t)
B = 1.0×10^{-4} W(b/t)^2
C = W/(111-b/t)
D = 1.0×10^{-4} W(b/t)^2

Prior to transporting sign panels, the support angles and wide flanged shapes shall be shop connected and remain on the sign.

2. **Plywood.** Plywood sign panels shall have a black or natural color overlay on both sides and a minimum thickness of ⅝ inches. The panels shall conform to the U.S. Product Standard PS-1-83 requirements for Group 1 wood species, Grade B-B veneer, exterior type, high density overlaid plywood. Inner plies shall meet the requirements of Section 3.8.1 Crossband Gaps and Center Gaps of the U.S. Product Standard PS-1-83. Inner plies shall have no continuous core gaps, tunnels, holes, or through openings that travel longitudinally or transversely through the plies as measured from the panel edge. Any crossband gaps or center gaps allowed by the U.S. Product Standard PS-1-83 shall be completely filled with a synthetic filler repair as approved by Section 3.3 Synthetic Repairs of the U.S. Product Standard PS-1-83. Edges shall be smoothed and then sealed with one coat of exterior oil base paint.

   The plywood shall be cut so that the face grain will be horizontal, except for diamond and triangular shaped signs, and signs with a horizontal dimension not exceeding 4 feet and a vertical dimension greater than 4 feet. All plywood signs 4 feet or less in height shall be one piece of plywood. For sign heights greater than 4 feet, a maximum of two pieces of plywood shall be used. The minimum width (perpendicular to the surface grain) of the smaller piece shall be one foot. When a one foot width is used, two bolts are required vertically at each post connection.

   Vertical joints in plywood signs are not allowed. Plywood sign panels shall not be spliced except where indicated on the sign details. Horizontal splices shall not be permitted through legends or symbols. Corners shall be rounded. Burrs at corners and mounting holes shall be removed.

The high density overlay surface of the plywood shall be prepared for application of sheeting by lightly abrading the surface with a product recommended for use by the supplier of the sheeting. Power sanding will not be permitted. The surface shall be wiped with a solvent and allowed to thoroughly dry according to the sheeting manufacturer's recommendations.

After the surface of the plywood has been prepared, care shall be taken to ensure that no grease, oil, or other contaminants come in contact with the surface.

3. **Aluminum Sheet.** Type III and Type IV aluminum sheet sign panels shall conform to the requirements for aluminum alloy 6061-T6, 5052-H38, or 5154-H38 of ASTM B 209.

   Type III aluminum sheet sign panels shall be fabricated from nominal 0.080 inch thick aluminum sheet with mill tolerance as specified in ASTM B 209. Type IV aluminum sheet overlay sign panels shall be fabricated from not less than nominal 0.040 inch thick aluminum sheet having a minimum thickness of 0.037 inches. Corners shall be rounded and there shall be no burring at the corners and mounting holes.

   The aluminum sheet shall be thoroughly degreased according to the sheeting manufacturer's recommendations. After degreasing, surface treating, and proper rinsing, sign panels shall be kept free of grease, oil, or other contaminants.

B. **Sign Face and Legend Material.**

1. **Reflective Sheeting Material.** Reflective sheeting for permanent signs shall meet ASTM D 4956 specifications for Type III high-intensity retroreflective sheeting and must be selected from the Qualified Products List.

   A 145 foot length roll of reflective sheeting may have no splices.

2. **Sheeting Application.** Legends shall be fabricated and applied according to the *Standard Highway Signs Manual* or as detailed on the plans. The lettering and spacing on all signs shall conform to the *FHWA Standard Alphabets for Highway Signs and Pavement Markings.*

3. **Direct Applied Reflective Legend.** The legend shall be cut with a smooth regular outline, free from ragged or torn edges, and having interior corners cut with a smooth 3/16 inch, ±1/16 inch, radius.

   The legend shall be applied according to the reflective sheeting manufacturer’s recommendations.

   For aluminum extruded sections (Type I) signs, the legend components shall be cut along each metal sign section joint after application of the legend.

4. **Non-Reflective Legend.** Black sheeting used for legend, borders, and arrows shall be non-reflective material unless otherwise stated. Where a black legend is required, it shall be ink, silkscreen method, or non-reflective sheeting. Application and materials shall be according to manufacturer's specifications.

C. **Sign Hardware.** Steel shapes, bars, and plates shall conform to ASTM A 36, or an approved equal, and shall be hot-dip galvanized according to ASTM A 123.

Bolts, washers, nuts, and straping shall be stainless steel. The stainless steel alloy for washers and bolts, other than U-bolts, shall conform to ASTM A 320, Grade B 8. Nuts shall be the self-locking nylon insert type and shall conform to ASTM A 320, Grade B 8F.

The stainless steel alloy for U-bolts shall conform to ASTM A 320, Grade B 8, Class 1. If U-bolts are formed from straight stock, forming shall be by cold working.

Aluminum alloy shapes and plates shall meet ASTM B 308, Alloy 6061-T6.

Cast post clips shall conform to ASTM B 108, Alloy 356.0-T6.

919.03 Delineators. Reflectors for delineators shall be fabricated from either plastic material or reflective sheeting material as shown on the plans. The Contractor shall provide a copy of the manufacturer's certification that the reflectors and posts meet the following requirements:

A. **Plastic Reflectors.** The reflectors for mounting on rigid post shall consist of a round, clear and transparent plastic face, called the lens, with a back fused to the lens under heat and pressure around the entire perimeter of the lens to form a unit sealed against dust, water, and vapor. The lens shall have a central mounting hole and a nominal reflecting area of 7 square inches. It shall have a smooth outside surface and a configuration inside to effect "cube-corner" retro-reflection. The manufacturer's trade mark shall be molded legibly into the face of the lens.

Plastic reflectors must have aluminum housings. An aluminum grommet with an inside diameter of 3/16 inch shall be expanded within the reflector mounting hole and flanged.

1. **Optical Performance.** At least 90 percent of the reflectors tested shall meet or exceed the values listed in Table 919-2 for the appropriate color and none of the reflectors tested shall produce results less than 80 percent of any of those values.

Table 919-2 Specific Intensity (SI) of Plastic Reflectors for Delineators

Color	Type	SI Candelas per Foot-Candle			
		Divergence angle, 0.1 Degrees		Divergence Angle, 0.2 Degrees	
		Entrance Angle, Deg.		Entrance Angle, Deg.	
		0	20	0	20
Crystal or Silver	A	120	50	84	35
Yellow	A	71	28	50	20
Red	A	29	11	21	8

B. **Reflective Sheeting Reflectors.** The reflective sheeting for mounting on flexible posts shall conform to ASTM D 4956 requirements for material, color, and resistance to weathering for Type III flexible high-intensity retroreflective sheeting.

The reflective sheeting used on flexible delineator posts shall conform to the reflector colors required at delineator locations and shall be applied according to the manufacturer's specifications. Yellow (amber) reflective sheeting shall be used in place of yellow delineators and white (silver) sheeting shall be used in place of crystal delineators at locations identified in the standard plans as requiring flexible delineator posts. A 3 by 6 inch piece of red reflective sheeting shall be placed on the backside of the flexible post indicating wrong-way movement for freeway ramps as identified in the standard plans.

C. **Mounting Hardware.** Mounting hardware for the plastic reflector shall consist of a solid pin (3/16-inch diameter) with annular locking grooves and a crimp type collar. The pin shall have a 7/16-inch diameter bearing head, a grip length equal to the total thickness of materials to be fastened together, and shall be ASTM B 308 aluminum Alloy 6061. The collar shall have a bearing diameter of ⅜ to $^{7}/_{16}$ inches. The collar shall be of proper size to fit the pin and shall be ASTM B 308 aluminum Alloy 6061 or 5052.

D. **Posts.** Delineator posts shall be either steel or flexible plastic, as shown on the plans. Steel delineator posts shall have a nominal weight of 1.33 pounds per foot and shall meet the requirements for steel posts as specified in subsection 919.04. Flexible plastic delineator posts shall be selected from the Qualified Products List.

919.04 Steel Post Sign Supports and Square Tubular Steel Sign Supports. Steel post sign supports (U-Channel) and square tubular steel sign supports (including sign posts, anchor sleeve, and anchor posts) shall meet ASTM A 702, Type A or Type B.

A. **Steel Post Sign Supports.** The finished posts shall meet the length requirement shown on the plans. The posts shall be straight and shall have a smooth uniform finish, free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges, or other defects affecting their strength, durability or appearance. Cross section and bolt hole diameter and spacing shall meet the requirements shown in the sign support typical plans. The center of the holes shall coincide with the centerline of the posts. The bolt holes shall be punched in such a manner that the face of the sign post shall have a smooth even surface. All holes and cutoff ends shall be free from burrs.

After fabrication and punching, steel posts shall be hot-dip galvanized according to subsection 907.03.D.

Finished posts (punched and coated) shall weigh at least 95 percent of the applicable nominal weight (pounds per foot) specified on the plans.

B. **Square Tubular Steel Sign Supports.** Square tubular steel sign supports shall conform to the chemical, mechanical, and geometric properties consistent with materials used in the crash tests referenced in Section 7.0 of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals*.

The sign posts, anchor sleeves, anchor posts, and all required connection hardware shall be of the size and type shown in the sign support typical plans.

Square tubular steel sign supports shall be sampled for testing at the frequency of one per heat per project. Type A certification shall be submitted with the sample.

The Contractor shall also submit a proof of compliance that the assembly has been crash tested according to the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals.* The proof of compliance shall include a copy of the FHWA approval letter to the manufacturer, indicating that the FHWA interprets the crash test results as being acceptable for use on Federal-aid projects.

The sign post, anchor sleeve, and anchor post shall be straight and shall have a smooth uniform finish, free from cracks and flaws or other defects affecting their strength or durability. All ends shall be free from burrs and shall be cut square to maintain telescoping characteristics.

Bolt holes of the diameter specified shall be accurately spaced on all four sides of the sign post, anchor sleeve and anchor post. Holes shall line up exactly opposite each other on opposing sides of the post in order to accommodate a bolt placed through two opposite sides. The center of the holes shall coincide with the centerline of the sign post, anchor sleeve and anchor post.

The bolt holes shall be punched in such a manner that the face of the sign post, anchor sleeve and anchor post shall have a smooth even surface.

After fabrication and punching holes, the sign post, anchor sleeve and anchor post shall be hot-dip galvanized according to thickness Grade 65 of ASTM A 123.

919.05 Sawed Wood Posts for Highway Signs. Sawed wood posts for highway signs are specified in section 912 and in the sign support typical plans.

919.06 Breakaway Column Sign Supports. Structural steel for the column sign supports and the bolts, nuts, and washers for the structural steel joints shall meet the requirements specified in the sign support typical plans.

Shims shall be fabricated from brass shim stock or brass strip conforming to ASTM B 36, copper alloy UNS No. C26000, half-hard rolled temper or galvanized sheeting conforming to ASTM A 526, Coating Designation G 90.

All galvanizing runs or beads shall be removed from contact surfaces of columns, plates, and washers.

Dimension tolerances, welding, and galvanizing requirements shall be as specified in subsection 919.07.

919.07 Cantilever Sign Supports.

A. **Types C through E.** The pipe for the vertical pole and horizontal arms shall meet the requirements for Grade B, Type E or S, steel pipe of ASTM A 53 or API 5L, Grade X42 to X52.

The gusset, flange, and base plates shall conform to the requirements for structural steel of ASTM A 36. All plates shall be free of sharp edges and irregularities.

B. **Types G and H.** Pipe for the vertical pole and the truss chords shall be fabricated from high-strength low-alloy steel meeting the requirements of Grade 50 steel of ASTM A 572, or an approved alternate, with the exception that the 50,000 psi yield strength requirement shall apply after fabrication.

The pipe shall meet ASTM A134 requirements for Electric-Fusion (Arc-Welded) Steel Plate Pipe, except hydrostatic testing will not be required and the restriction of 16 inches and over in diameter shall not apply.

Pipe for vertical and diagonal truss members shall meet Grade B, Type E or S, steel pipe of ASTM A 53 or shall be fabricated from structural steel meeting ASTM A 36.

Plates shall conform to the requirements for structural steel of ASTM A 36. All plates shall be free of sharp edges and irregularities.

C. **Castings.** The pole top and end cap castings shall conform to Class A castings of ASTM A 126.

D. **Bolts for Arm Connections.** Arm connection flanges shall be connected with galvanized high-strength steel bolts, nuts, and washers meeting subsection 906.06.

E. **Dimension Tolerances.** The allowable tolerances for each type of commodity shall conform to ASTM A 6 or the applicable ASTM standard to which the material is ordered.

F. **Welding.** The requirements for welding as specified in AWS D1.1, *Structural Welding Code-Steel* shall apply as amended herein, or by contract documents.

G. **Galvanizing.** Steel anchor bolts shall be galvanized for a length not less than 20 inches from the threaded end. Bolts, nuts, and washers shall also be hot-dip galvanized. Galvanizing shall conforming to ASTM A 153.

After all welding of assemblies and sign support attachments has been completed, base plates and weldments shall be blast cleaned to remove excess mill scale and welding slag. Other areas may require blast cleaning as directed by the Engineer. The supports shall be hot-dip galvanized according to ASTM A 123.

919.08 Truss Sign Supports. All trusses shall be cambered such that the ordinate, within the allowable tolerance, at the center of the assembled truss, prior to any dead load deflection, shall be as stated on the plans for the span length and type specified. Bearing surfaces shall be in full contact in the relaxed position prior to tightening the flange bolts. The method of cambering the structure shall be at the discretion of the fabricator, with approval of the Engineer, provided that the method does not induce stress into the truss.

A. **Materials.** All hollow structural tubing shall conform to ASTM A 500, Grade B, and shall be safeguarded against embrittlement according to ASTM A 143.

Pipe shall conform to Grade B, Type E or S steel seamless pipe of ASTM A 53.

Bar, plate, and rolled structural shapes shall conform to ASTM A 36. Bars, plates, and shapes shall be free of sharp edges and irregularities.

Use ASTM A320, Grade B8, Class 1 stainless steel for U-bolts and washers. Nuts shall be self-locking nylon insert type according to ASTM A320, Grade B8F.

Nuts used in the upper clamp connection of the vertical end support assembly and on all U-bolts shall be of the self-locking type.

Flange connections of truss units and the alternate bolted web-to-chord connection shall be assembled with galvanized high-strength steel bolts, nuts, and washers meeting the requirements specified in subsection 906.06.

B. **Welding.** The requirements for welding as specified in AWS D1.1, *Structural Welding Code-Steel* shall apply as amended herein, or in contract documents.

C. **Dimension Tolerances.** The allowable tolerances for variations in cross section, flatness, length, straightness, thickness and camber of all material before and after fabrication shall conform to the applicable requirements of ASTM A 6 and AWS D1.1.

D. **Galvanizing.** Galvanize truss units according to ASTM A123. All base plates and weldments shall be blast cleaned to remove excess mill scale and welding slag prior to galvanizing. Other areas may require blast cleaning as directed by the Engineer.

Precautions and safeguards to be used for obtaining high quality galvanized coatings and to minimize distortion and warpage during galvanizing shall conform to ASTM A 384 and ASTM A 385.

All sections of fabricated pipe work or tube assemblies shall be interconnected with open tee or miter joints and each enclosed section provided with a vent hole at each end to provide drainage for the molten zinc and to prevent hazard to personnel engaged in the galvanizing process.

All individual pipe, tube, and bar members shall be hot-dip galvanized according to ASTM A 123.

919.09 Overhead Lane Assignment Structures. Overhead lane assignment structures shall conform to the sign support typical plans and traffic signal contract typical construction plans.

919.10 Aluminum Structures.

A. **Materials.** Primary members shall be ASTM B 308 aluminum alloy 6061-T6 and secondary members shall be aluminum alloy 6063-T6. Primary and secondary members shall be according to ASTM B 221.

Plates shall be ASTM B 308 aluminum alloy 6061-T6 and shall be according to ASTM B 209. All plates shall be free of sharp edges and irregularities.

Base, fringes, and seat castings shall be ASTM B 108 aluminum alloy 356.0-T7. Other castings shall be ASTM B 108 aluminum alloy 356.0-F. Castings shall be according to ASTM B 26.

Stainless steel bolts and washers shall be according to ASTM B 26, Grade B8. Nuts shall be the self-locking with a nylon insert according to ASTM A 320, Grade B8F.

Stainless steel U-bolts shall be according to ASTM A 320, Grade B8, Class 1. Washers shall be according to ASTM A 320, Grade B8F.

B. **Dimension Tolerances.** Allowable tolerances of aluminum shall be according to ANSI H 35.2.

C. **Welding.** Welding shall be according to AWS D1.2, *Structural Welding Code-Aluminum*.

All welders and welding procedures shall be approved by testing, as directed by the Engineer, prior to starting any work. The procedure tests shall be according to AWS D1.2, *Structural Welding Code-Aluminum*. The procedure used for production welding of any particular joint shall be the same as used in the procedure qualification for that joint. All procedure tests shall be witnessed by a representative of the Department. The Department will designate the type of welds and tests required to qualify the welders.

Shop welders shall remain qualified for a period of 24 months if work is being performed on a continual basis for the Department. The Engineer may require a confirming qualification test during the progress of the work.

The cost of testing qualification or confirmation specimens shall be at the department's expense, except when the first test specimen fails to meet the specified requirements.

Additional specimens for test submitted by the Contractor shall be at the Contractor's expense.

Undercut shall not be more than 0.01 inch deep when its direction is transverse to the primary stress in the component containing the undercut. Undercut shall not be more than 0.03 inch deep when its direction is parallel to the primary stress in the component containing the undercut.

D. **Inspection.** Welds shall be inspected visually or by the layer method. Inspection by the layer method shall consist of the inspection of each layer of weld metal before the next successive layer is deposited. Fillet welds and partial penetration groove welds shall be inspected by dye penetrant testing (PT). Full penetration groove welds shall be inspected by ultrasonic testing (UT). Location and frequency shall be determined by the Engineer.

919.11 Sign Foundations.

A. **Concrete.**

1. **Wood Posts.** Concrete for wood post foundations, when required, shall be Grade M as specified in section 601.

2. **Breakaway Columns.** Concrete for breakaway column foundations shall be Grade M as specified in section 601.

3. **Cantilevers and Trusses.** Concrete for cantilevers and truss sign foundations shall be Grade P1 or S2 as specified in sections 601 and 701, respectively.

4. **Cantilever Drilled Piles.** Concrete for all drilled shafts for piles shall be Grade S2 or T as specified in section 701. Grade S2 shall be used in dry conditions and Grade T shall be used for underwater placement. Slump is modified for site conditions as provided below:

Slump Range	**Condition**
4 - 6 inches	Dry, uncased bore hole
6 - 8 inches	Temporary cased bore hole
8 - 10 inches	Concrete placed under water or under drilling slurry

B. **Curing Compound.** Curing compounds are as specified in section 903.

C. **Steel Reinforcement.** When required, steel reinforcement is as specified in sections 706 and 905.

D. **Anchor Bolts and Nuts.** Anchor bolts and nuts are as specified in subsection 908.15.

E. **Casings.** Casings for cantilever drilled piles shall be made of ASTMA A 252, Grade 2 steel, shall be smooth, watertight, and of ample strength to withstand handling stresses and external subsurface pressures. The inside diameter of casing shall not be less than the specified size of the shaft.